The IVS and Its Impact on Geodesy and Geophysics

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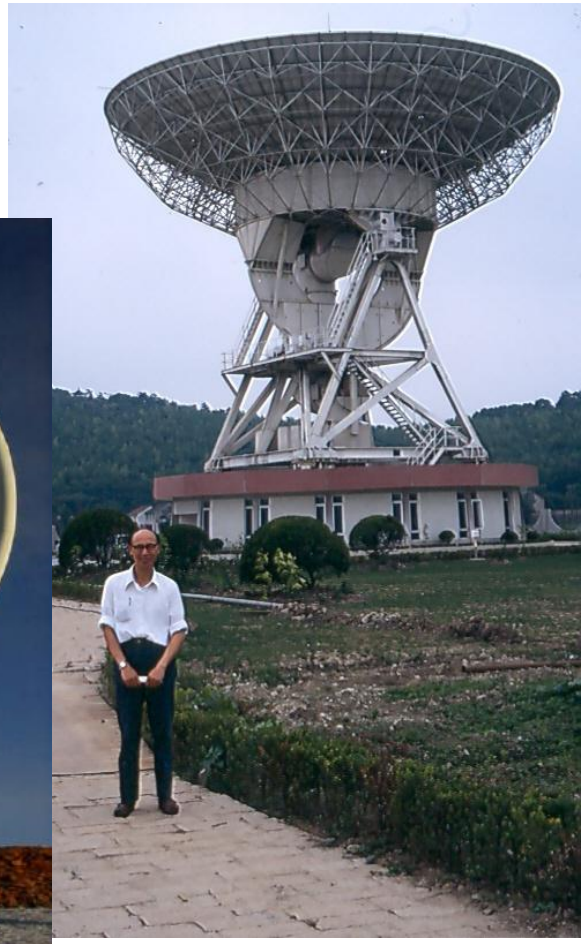
Very Long Baseline Interferometry

Kashima

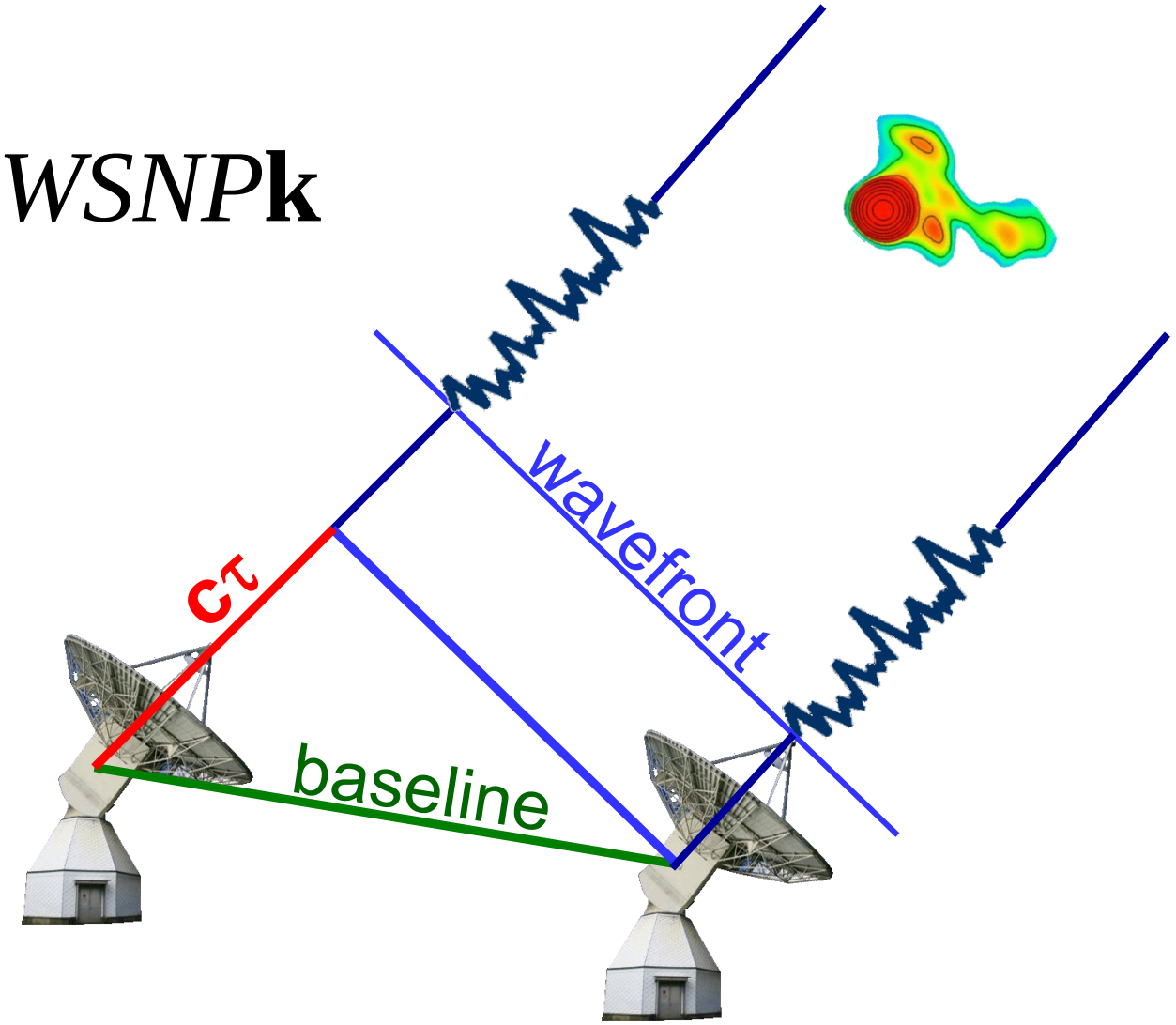
O'Higgins



Seshan

The Principle of VLBI

$$\tau = -\frac{1}{c}\mathbf{b}WSNP\mathbf{k}$$



The Principle of VLBI

$$\tau = -\frac{1}{c}\mathbf{b}WSNP\mathbf{k}$$

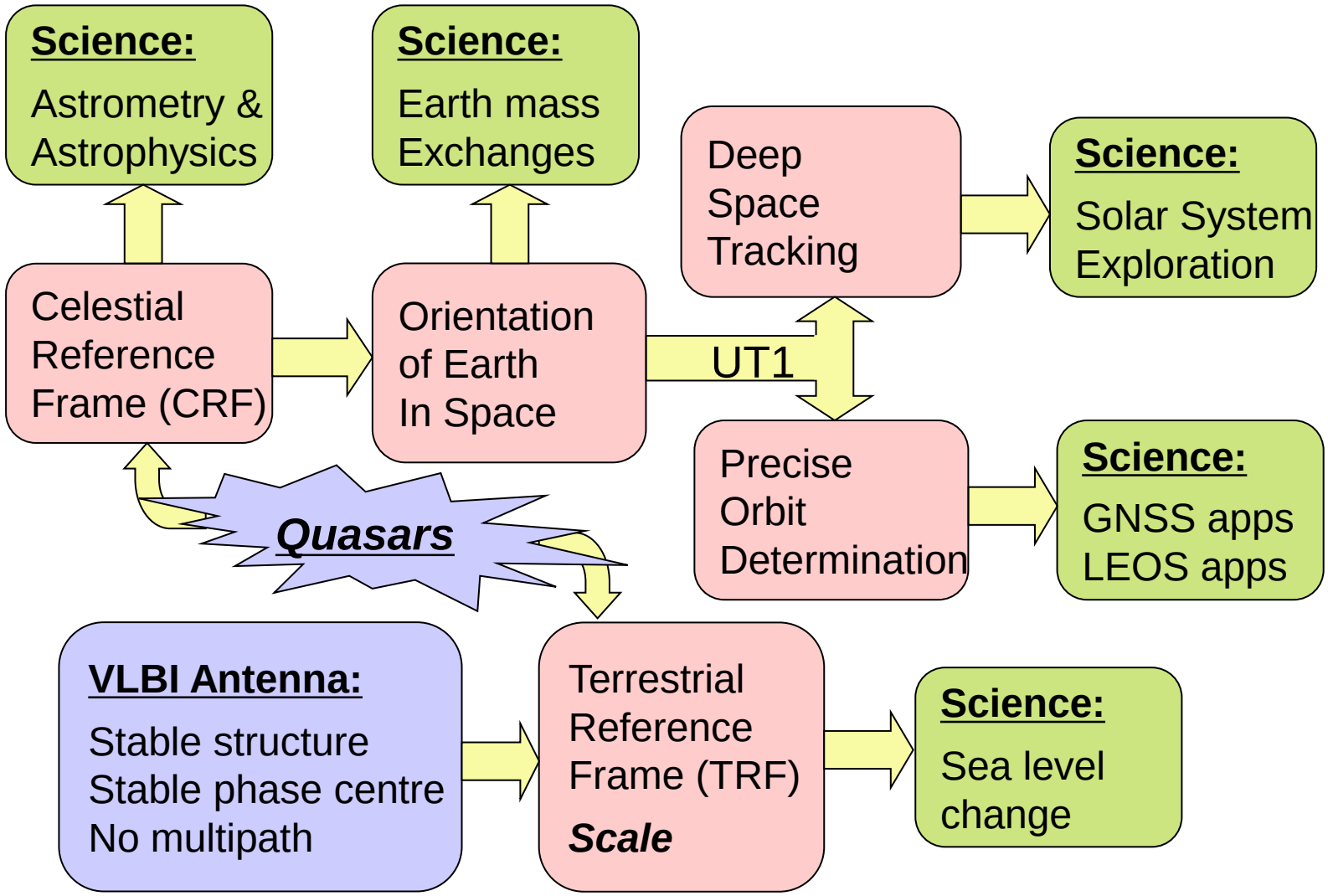
$\mathbf{b}$ baseline vector between two stations

$\mathbf{k}$ unit vector to radio source

EOP – Earth Orientation Parameters

- W rotation matrix for polar motion
- S diurnal spin matrix
- N nutation matrix
- P precession matrix

VLBI and Science



International VLBI Service for Geodesy and Astrometry (IVS)

IVS is a service of

- **IAG** – International Association of Geodesy
- **IAU** – International Astronomical Union
- **WDS** – World Data System (currently applying for membership)

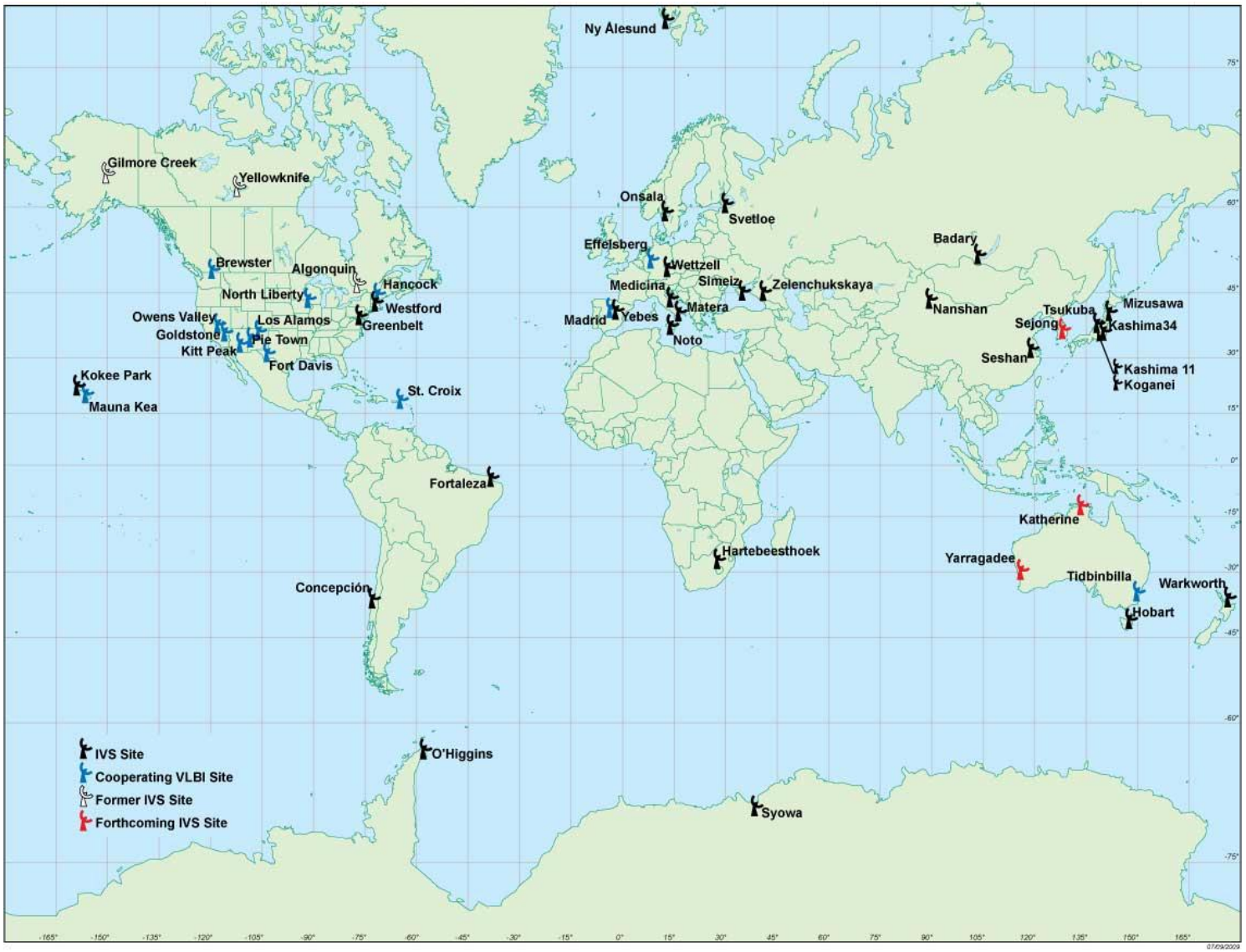
IVS goals:

- To provide a service to support geodetic, geophysical and astrometric research and operational activities
- To promote research and development in the VLBI technique
- To interact with the community of users of VLBI products and to integrate VLBI into a global Earth observing system

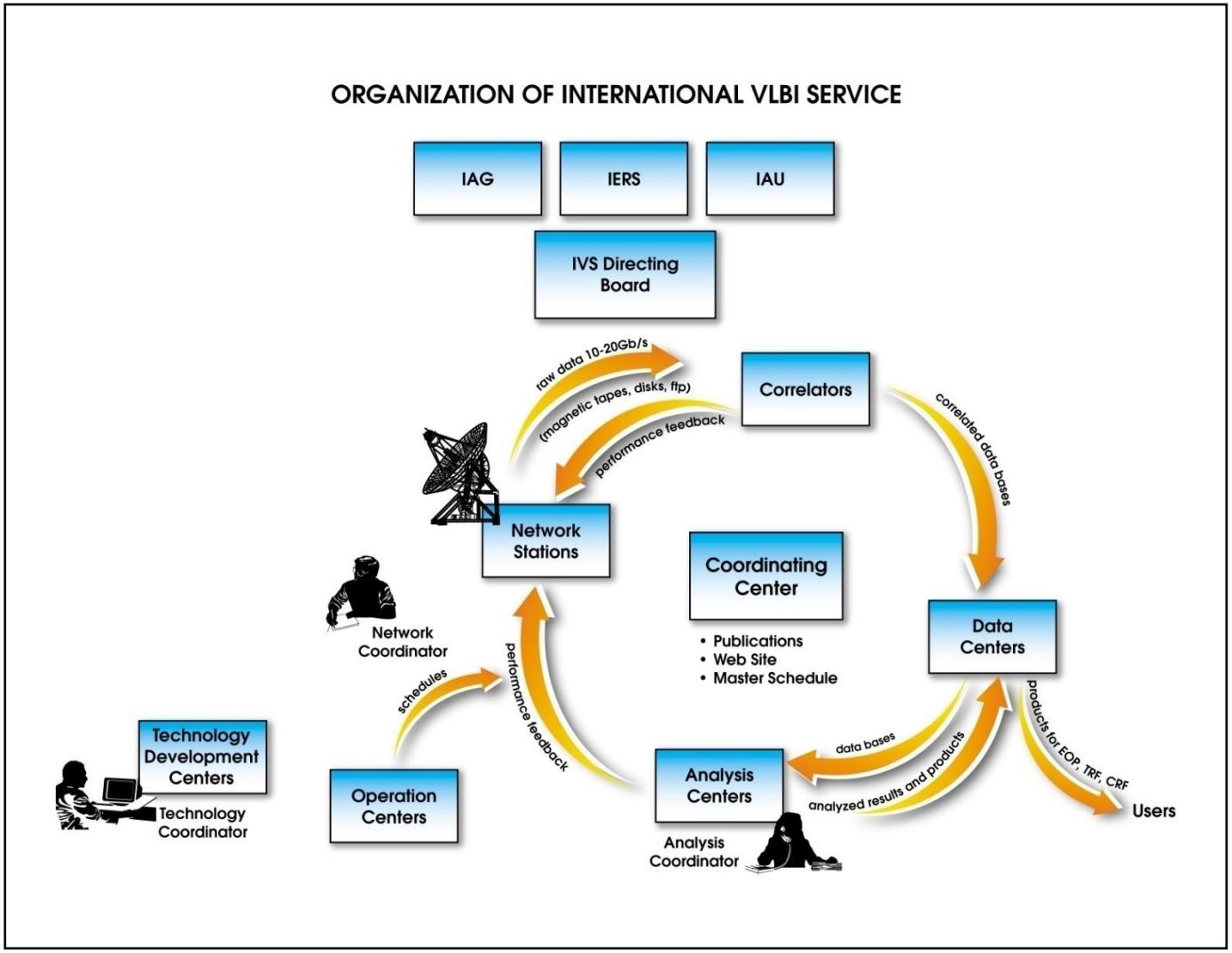
Main tasks of the IVS are: coordinate VLBI components, guarantee provision of products for CRF, TRF, and EOP

- IVS inauguration was on March 1, 1999
- IVS 10th Anniversary event on March 25, 2009
- Around 80 Permanent Components supported by 40 institutions in 20 countries
- ~280 Associate Members

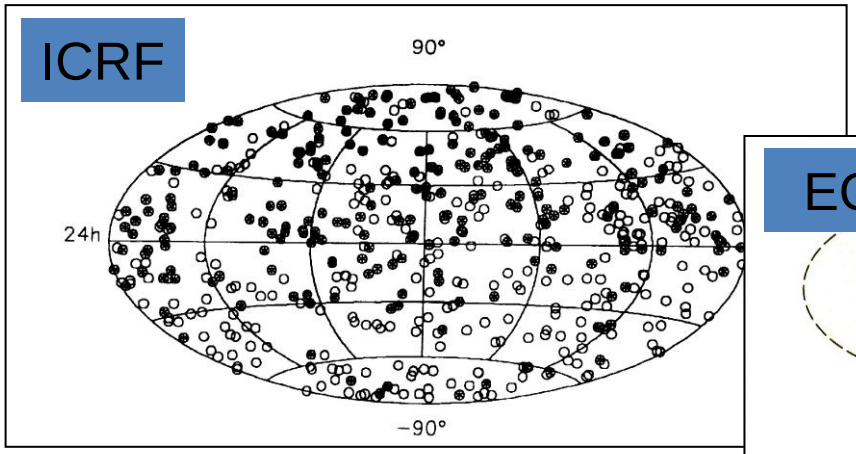
IVS Network Stations

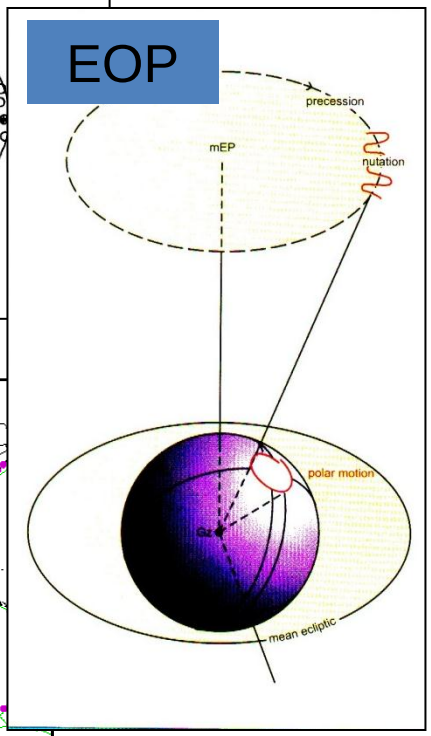


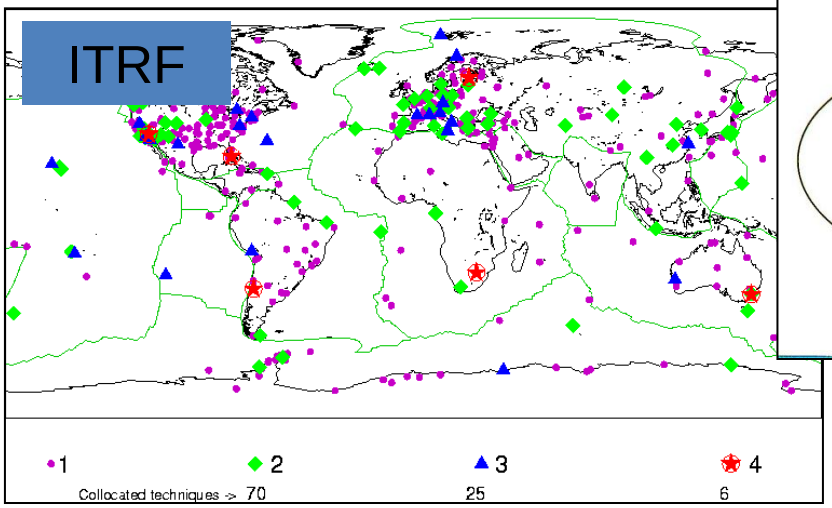
IVS Organization



IVS Products





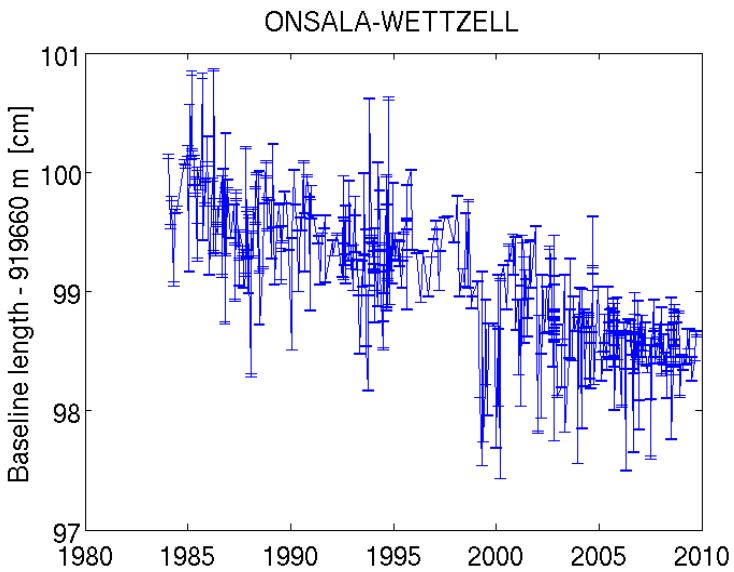


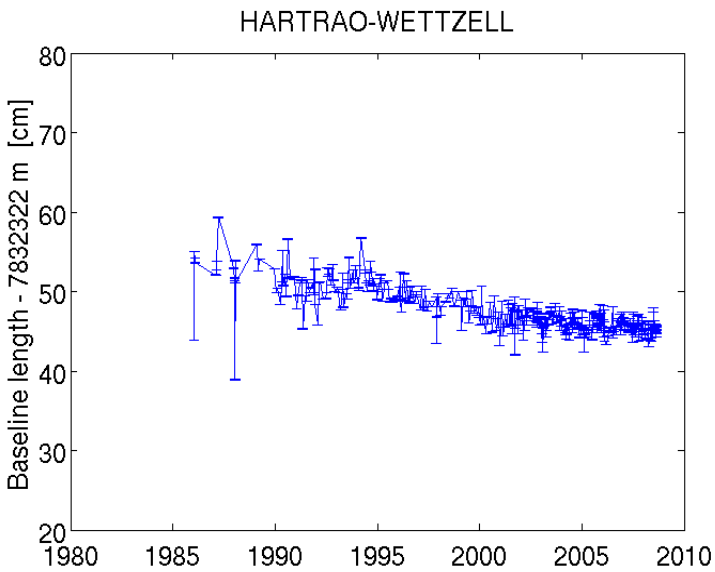
- **ICRF:**
  - Radio Source Positions
- **ITRF:**
  - Station Positions
  - Station Velocities
- **EOP:**
  - Celestial Pole ($d\varepsilon$, $d\psi$)
  - Polar Motion (x_p, y_p)
  - UT1-UTC (DUT1)

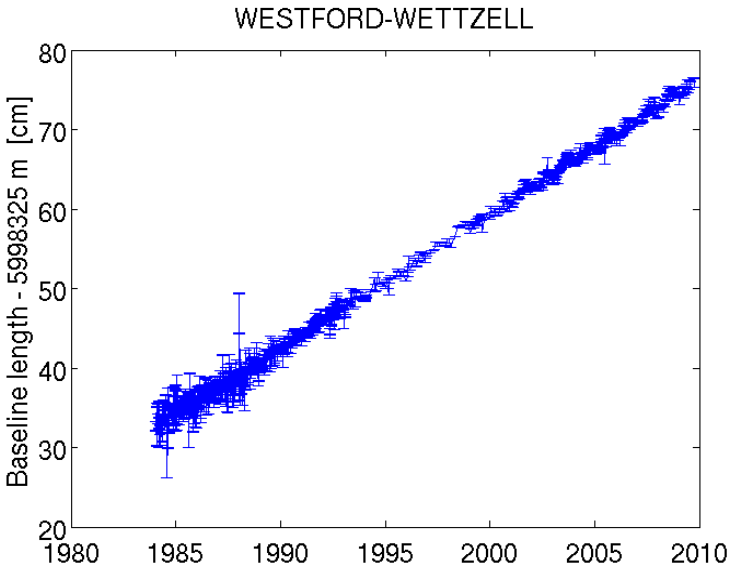
IVS Products

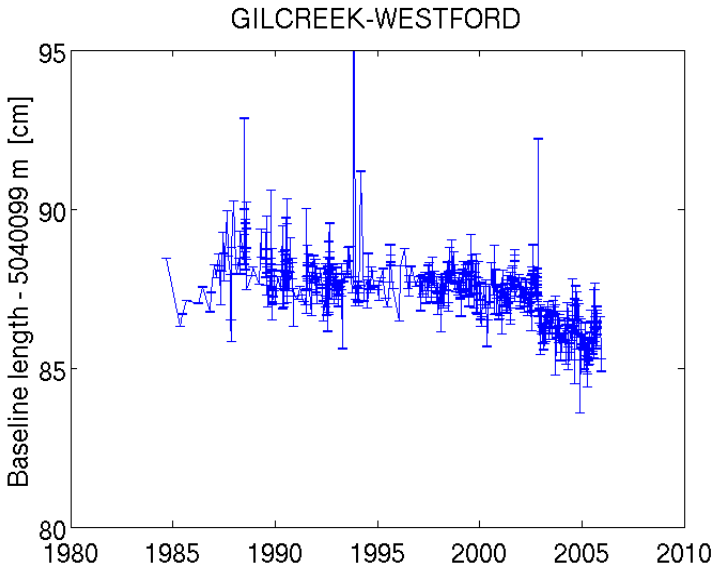
- Earth Orientation Parameters (EOP):
  - 24-hour sessions (all EOPs)
  - 1-hour Intensives (UT1–UTC)
- Terrestrial Reference Frame (ITRF2008)
- Celestial Reference Frame (ICRF2)
- One-day EOP+station parameters
- Tropospheric Parameters
- Baseline Lengths
- VLBI Terrestrial Reference Frame (VTRF)

Station motions

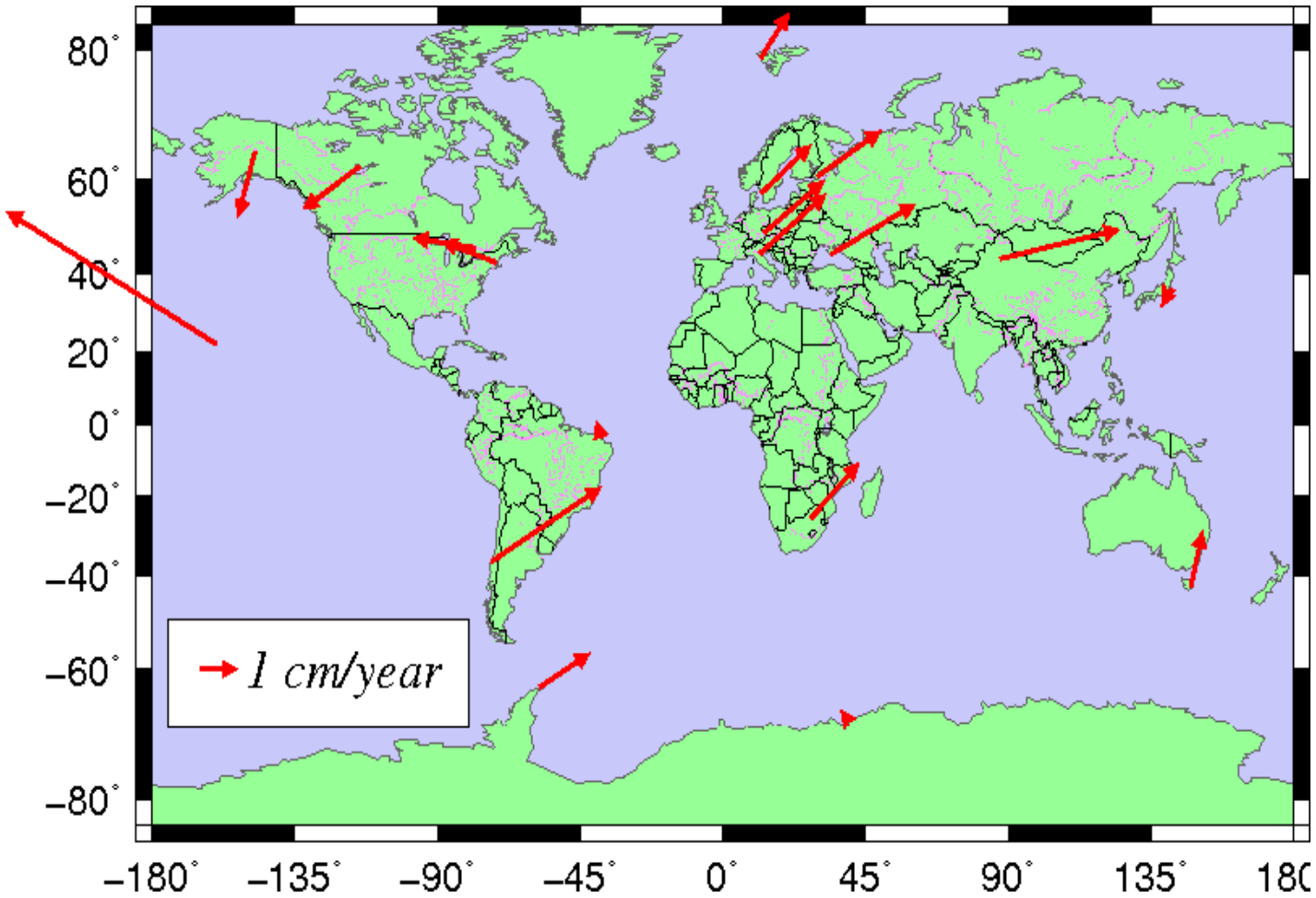




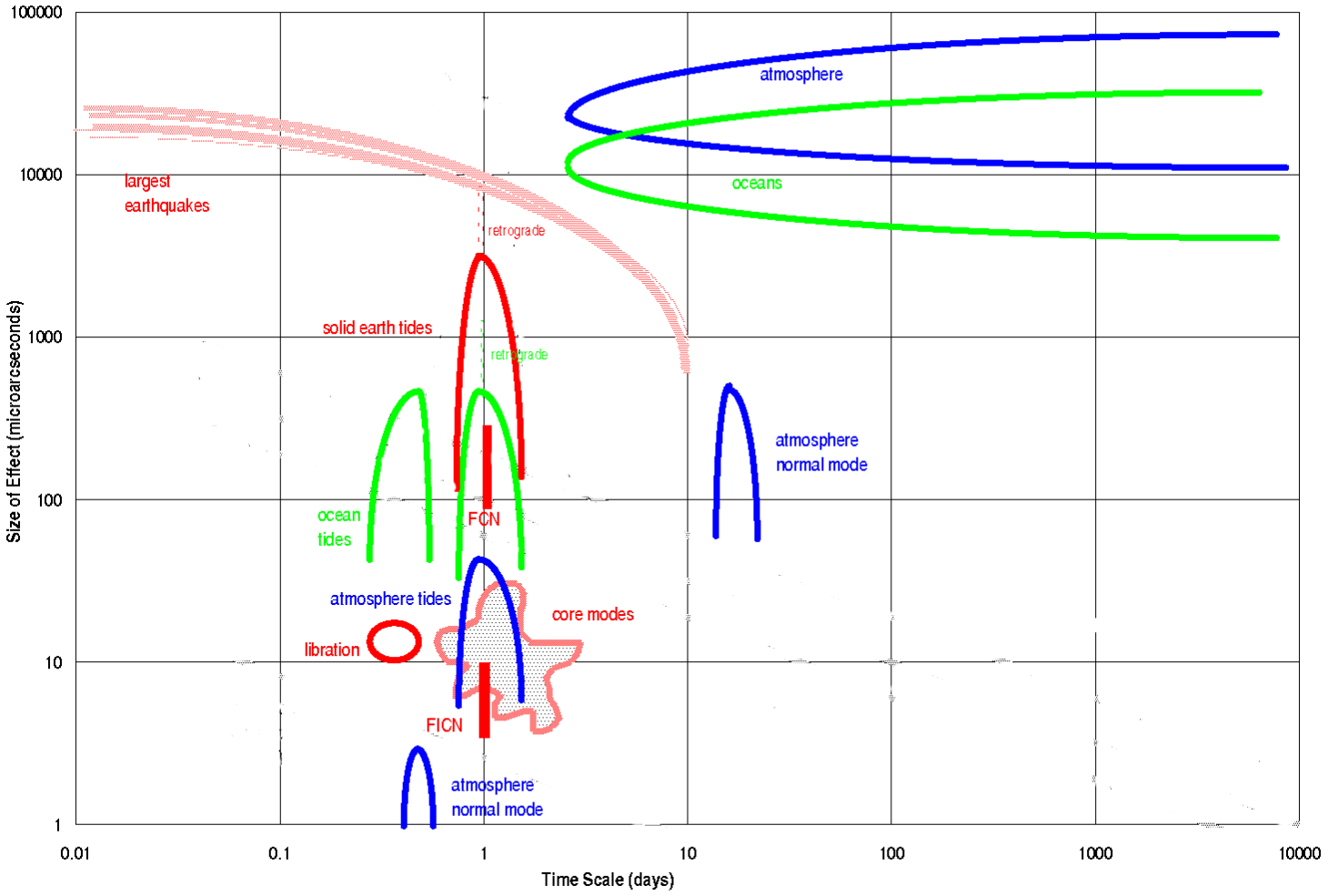




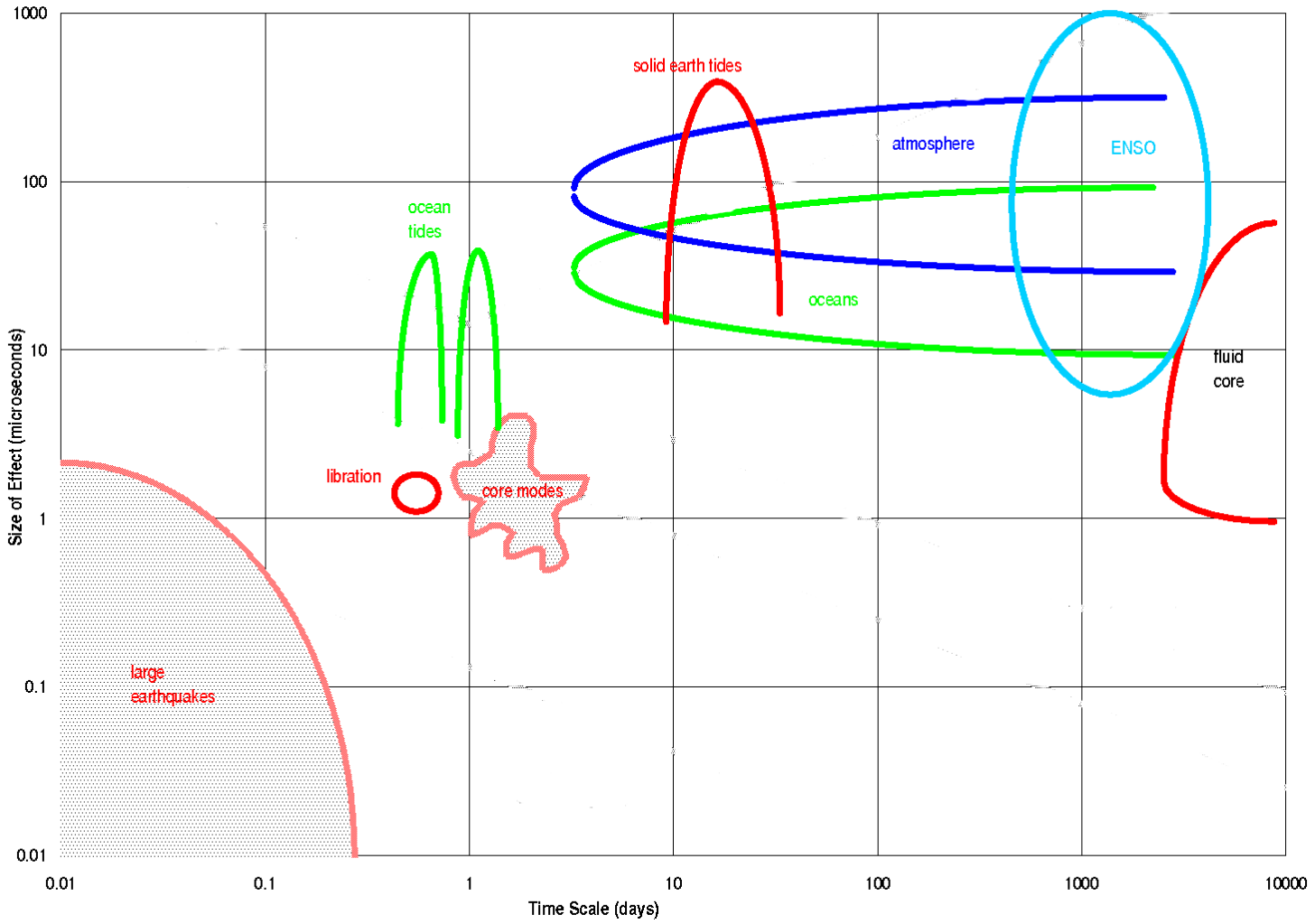
Station Velocities Measured by VLBI



Geophysical Effects on Polar Motion

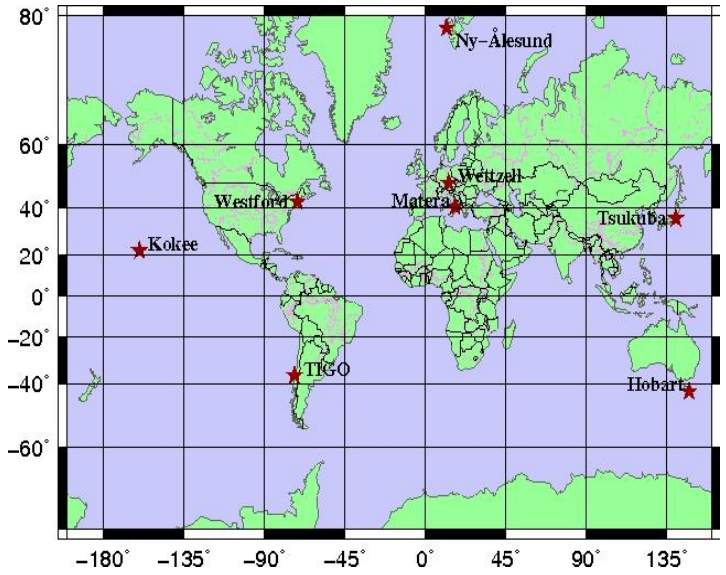


Geophysical effects on DUT1

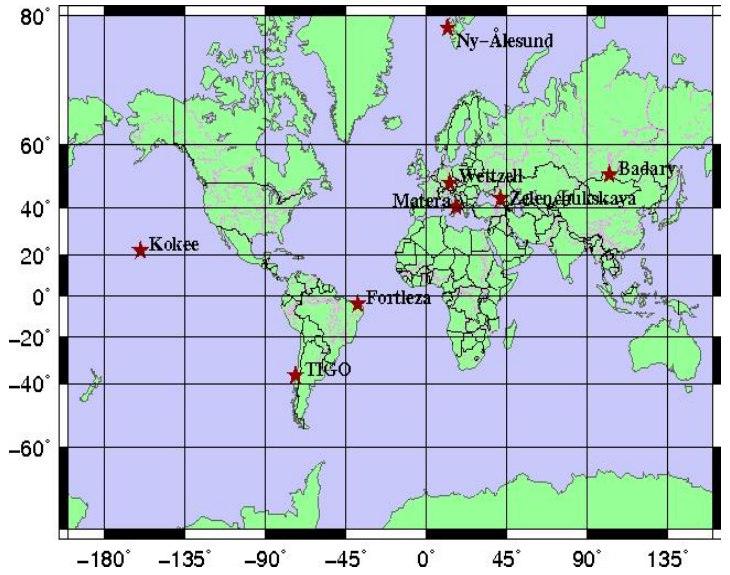


Monitoring Earth Rotation with IVS R1 and R4 Sessions

R1 network 16 March

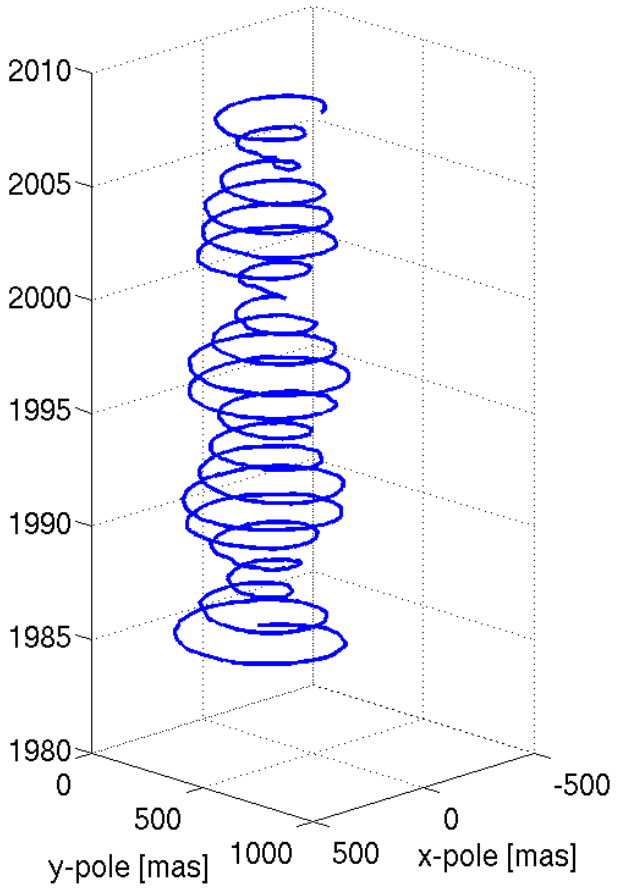


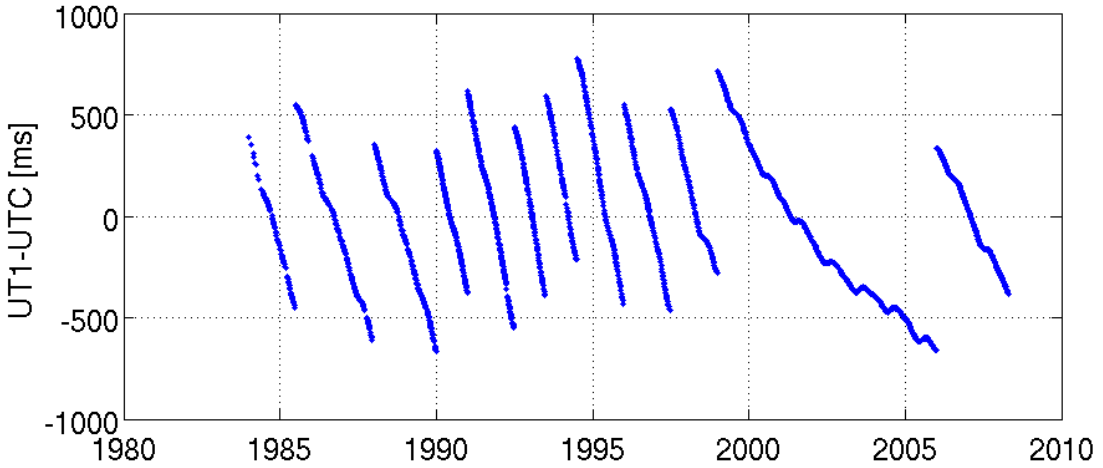
R4 network 19 March



- Carried out every Monday (R1) and Thursday (R4)
- For highest accuracy, the stations should be distributed globally. Important to have stations also in remote locations, e.g. in the Arctic
- Primary input to UT1 and nutation time series of the IERS (International Earth Rotation and Reference Systems Service)

Earth rotation parameters estimated by VLBI 1984-2008





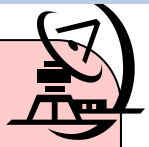
VLBI2010: Why do we need it?

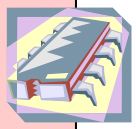
Aging systems (now ~30 years old):

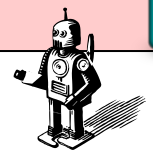
- Old antennas
- Obsolete electronics
- Costly operations
- RFI

New Technology:

- Fast cheap antennas
- Digital electronics
- Hi-speed networks
- Automation







New system

New requirements:

- Sea level rise
- Earthquake processes
- 1-mm accuracy
- GGOS

VLBI2010 System Characteristics

	Current	VLBI2010
antenna size	5–100 m dish	~ 12 m dish
slew speed	~20–200 deg/min	≥ 360 deg/min
sensitivity	200–15,000 SEFD	≤ 2,500 SEFD
frequency range	S/X band	~2–14 (18) GHz
recording rate	128, 256 Mbps	8–16 Gbps
data transfer	usually ship disks, some e-transfer	e-transfer, e-VLBI, ship disks when required

VLBI2010 at NASA/Goddard